

*Dietetics in Tuberculosis: Principles and Economics.**

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Object of Research.—The object of our research was to obtain reliable data upon which to draw conclusions as to the best lines upon which to base the dietetic treatment of pulmonary tuberculosis. In 1899, when this work was first commenced, the sanatorium treatment of consumption and other forms of tuberculosis was rapidly becoming adopted in this country. One of the most noteworthy features of this treatment was the systematic prescription of diets of a very high nutritive value. In the absence of any reliable authorities on the dietetics of tuberculosis, the practice of giving very large diets became very general, in spite of warnings from physiologists that such a method of treatment was probably unsound. Some preliminary observations, which we made at Sheffield Royal Infirmary in 1899 upon the metabolism of several consumptive patients treated on very large diets, suggested to us that an extended series of such observations might enable us to place the dieting of tuberculosis upon a more scientific foundation. Our series of observations has extended over seven years, and this paper represents an abstract of our final report.

Research 1.

We hoped, as a result of our first series of observations, to establish :—

(1) The best general principles upon which to construct diets for the treatment of tuberculosis.

(2) A standard diet in terms of proteid, fat, carbohydrate, and total calorie value for the treatment of tuberculosis.

Method of Observation.—The progress made by 200 cases of pulmonary tuberculosis, representing well-marked stages of the diseases, were carefully observed whilst treated on definite diets, the general lines of treatment being the same in every case.

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In the case of every patient that was observed, we first determined the diet which was physiological for the individual, when in ordinary health, up to his average body weight, and at physiological rest. This physiological diet was then increased in certain definite amounts of proteid, fat, or carbohydrate. The actual diet prescribed was carefully constructed so as to give the nutritive value decided upon. This diet was given in measured and weighed amounts, and anything left was also weighed or measured. In this way an accurate record of the food actually consumed by the patient was arrived at and its nutritive value calculated. Careful clinical observations were made on all the patients, especially as to the improvement in the morbid process in the lungs, gain of weight, and improvement in general health. In a large proportion of cases, metabolic observations were also made. Sometimes these observations were made during a four-day period once a month; in other cases they were made daily for periods varying from a week to three months. The points especially studied were:—

- (1) The absorption of fat and nitrogen.
- (2) The amount of the excretion of nitrogen.
- (3) The form in which the nitrogen was excreted, viz., whether simple or in the more highly elaborated forms, and their percentage relation.
- (4) The amount of intestinal putrefaction, as evidenced by the ratio between the aromatic and the alkaline sulphates excreted in the urine.

Conclusions of Research 1.—The following are satisfactory principles upon which to construct dietaries for tuberculous patients:—

(1) The physiological diet (viz., the diet which contains the exact amount of carbon and nitrogen necessary to balance the amounts of the substances excreted) for every tubercular individual when in normal health and at physiological rest, should first be ascertained, and this physiological diet should form the basis of the diet prescribed for the treatment.

(2) The amount of proteid in the physiological diet should be increased by 30 per cent., and this increase should be maintained until the disease is obsolete.

(3) If the patient is much under weight, the calorie value of the physiological diet should also be increased 30 per cent. in the purely energy-giving foods, viz., in fats or carbohydrates, or in both. This increase should be maintained until the weight becomes stationary, at a point a few pounds in excess of the patient's normal weight. A decrease of 15 per cent. can then be made, and the diet thus altered should be continued until the disease is obsolete.

(4) The meals must not be too bulky, but somewhat inclined to concentration, so as to give the comparatively large amount of nourishment in a but

slightly increased bulk of food stuffs. In the case of the consumptive working classes this last rule does not always apply, since they are used to taking diets of large bulk.

(5) The meals should be given at considerable intervals; they should be well cooked and as varied as possible.

Standard Diet for the Treatment of the average Tubercular Patient.

The following table gives the nutritive value of the average diets taken by 49 tubercular patients throughout their course of sanatorium treatment. These 49 patients have been selected inasmuch as they all made very good recoveries.

The average of these 49 satisfactory diets works out at

Proteid.	Fat.	Carbohydrate.	Calories.
150	150	250	3000

These figures, in our opinion, may be taken as representing the nutritive value of a diet which is satisfactory as a standard diet for the treatment of the average person suffering from tuberculosis. We have, as a matter of fact, adopted this standard in our sanatorium practice for the past few years, and found it to be most satisfactory. The standard diet which we have found to be best for tubercular women has a somewhat lower nutritive value, viz.:—

Proteid.	Fat.	Carbohydrate.	Calories.
126	150	220	2814

The following actual diets give the nutritive value of the above standard diets:—

Article of food as served.	Amount prescribed.	
	For men.	For women.
Milk	1500 c.c.	1500 c.c.
Bread	180 grammes.	135 grammes.
Porridge	120 "	120 "
Butter	45 "	45 "
Breakfast meat, such as bacon, fish, etc.	30 "	30 "
Ordinary meat	180 "	150 "
Pudding	300 "	180 "
Vegetables	q.s.	q.s.

Table I.

On admission.				Diet.		On discharge.					
No. of lobes diseased.	Temperature range, °C.	Digestion.	Weight in kilos.	Relation to normal weight.	Proteid.	Fat.	Carbo-hydrate.	Lung disease.	General health.	Weight in kilos.	Temperature range, °C.
Cases with early disease.											
3	37.9-38.4	Normal	57.0	- 6.3	161	154	255	Complete arrest	Complete restoration	67.8	Normal
2	Normal	Poor	57.0	- 5.4	152	121	226	Incomplete arrest	Excellent	64.5	"
2	37.2-37.9	Normal	66.9	- 5.8	168	162	278	Complete arrest	Complete restoration	71.8	"
1	36.9-37.6	Impaired	76.0	equal to	172	156	268	"	"	76.9	"
2	Normal	Normal	58.0	- 6.3	184	166	268	Incomplete arrest	"	62.0	"
1	37.9-38.4	"	57.0	- 6.8	145	138	247	"	"	71.0	"
1	36.6-37.5	"	57.5	- 3.0	136	132	228	"	"	63.8	"
1	36.6-37.9	"	51.1	- 9.9	155	148	260	Complete arrest	"	57.0	"
3	37.0-37.6	"	53.0	- 7.7	160	156	270	Complete arrest	Largely restored	65.2	"
1	Normal	"	76.1	- 5.8	162	158	242	"	Complete restoration	82.3	"
2	37.2-37.9	"	63.0	-11.7	153	148	252	"	"	76.9	"
1	37.2-37.6	"	58.0	- 7.7	151	152	242	"	"	64.4	"
2	37.9-38.4	"	56.5	- 3.0	168	156	282	"	"	64.4	"
2	37.0-37.5	"	61.1	- 9.4	180	156	276	"	"	68.5	"
2	Normal	"	64.7	- 5.8	153	152	232	"	"	67.3	"
1	"	"	59.5	equal to	145	150	254	"	"	63.7	"
1	"	"	52.5	- 6.3	151	144	248	"	"	75.0	"
1	"	"	60.0	- 6.3	148	150	246	"	"	69.6	"
1	"	"	72.8	equal to	151	150	248	"	"	63.6	"
1	"	"	56.2	equal to	152	148	256	"	"	65.8	"
2	"	"	60.9	- 2.2	166	178	236	Incomplete arrest	"	71.8	"
1	"	"	69.6	equal to	162	156	256	"	"	64.2	"
2	"	"	68.3	- 1.5	171	156	264	"	"	71.0	"
1	"	"	63.0	- 2.4	158	158	284	"	"	74.6	"
1	"	"	63.6	- 2.8	160	150	282	"	"	61.0	"
1	"	"	70.5	equal to	162	150	198	"	"	87.8	"
1	"	"	60.0	equal to	152	133	280	"	"		
1	"	"	87.2	- 2.8	138	120		"	"		
Cases with advanced disease.											
4	37.2-38.0	Normal	58.8	-12.6	143	181	255	Incomplete arrest	Incomplete restoration	67.0	37.2-37.8
5	35.7-37.4	"	51.5	- 5.4	120	148	239	Very considerably arrested	Excellent	58.8	36.9-37.4
4	37.2-38.3	"	45.7	-13.1	155	135	235	"	Very greatly improved	36.5	Normal
2	Normal	Impaired	76.0	equal to	148	142	245	"	"	76.0	"
5	37.1-37.4	"	61.5	- 4.5	160	150	244	Complete arrest	Complete restoration	70.0	37.0-37.5
3	37.0-37.3	Very fair	49.7	- 6.3	147	155	261	Incomplete arrest	Very good	55.6	Normal
3	Normal	"	65.6	- 6.3	151	147	252	"	"	70.0	
3	37.0-37.4	Poor	54.0	- 8.0	158	136	220	Complete arrest	Complete restoration	60.0	36.9-37.3
3	36.9-38.9	Very fair	62.0	- 6.3	162	155	271	Incomplete arrest	"	85.0	36.9-37.3
2	Normal	Normal	73.3	- 8.10	161	153	266	"	Perfectly restored	76.0	36.9-37.3
2	37.2-37.4	"	52.4	- 3.1	134	160	260	"	Excellent	61.0	Normal
3	37.1-37.4	"	55.7	- 4.0	150	134	188	Very much improved	Very much improved	57.9	36.9-37.3
3	36.9-37.5	"	55.7	- 5.0	150	136	240	Much improved	Largely restored	62.4	36.9-37.3
3	Normal	Impaired	66.0	- 2.7	153	138	248	Very much improved	"	62.4	36.9-37.3
3	36.9-37.5	"	62.0	- 5.9	140	142	250	"	"	62.4	"
3	36.9-37.5	"	49.3	-16.3	153	158	275	Very largely arrested	"	59.3	"
2	Normal	"	61.0	- 2.7	148	148	278	"	"	63.8	"
3	37.0-37.5	Good	70.6	equal to	148	142	242	Very much improved	"	71.0	"
3	Normal	Impaired	55.2	- 4.5	151	161	273	Very considerably arrested	Much improved	60.0	"
1	37.2-38.0	Poor	71.0	-11.0	141	138	231	Much improved	Good	73.7	37.1-37.5
5	37.2-37.5	"	66.0	- 2.7	169	145	198	Improved	Improved	67.0	Normal
Cases with advanced disease.											
4	37.2-38.0	Normal	58.8	-12.6	143	181	255	Incomplete arrest	Incomplete restoration	67.0	37.2-37.8
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3	36.9-37.5	"	62.0	- 5.9	140	142	250	"	"	62.4	"
2	36.9-37.5	"	49.3	-16.3	153	158	275	Very largely arrested	"	59.3	"
2	Normal	"	61.0	- 2.7	148	148	278	"	"	63.8	"
3	37.0-37.5	Good	70.6	equal to	148	142	242	Very much improved	"	71.0	"
4	Normal	Impaired	55.2	- 4.5	151	161	273	Very considerably arrested	Much improved	60.0	"
1	37.2-38.0	Poor	71.0	-11.0	141	138	231	Much improved	Good	73.7	37.1-37.5
5	37.2-37.5	"	66.0	- 2.7	169	145	198	Improved	Improved	67.0	Normal

Observations on Tubercular Patients treated with Very Large Diets.

Careful observations have been made upon tubercular patients treated on the very large diets prescribed in many sanatoria, for instance, on diets with a daily proteid value of 200 grammes or more, and a total calorie value of 4000 or more.

Clinical Results of these Observations.—Patients made much less satisfactory all round progress on the very large diets than on diets of considerably smaller nutritive value. Weight was gained in nearly every case, in some to a very large extent, and very rapidly, but this gain of body-weight was not associated with any more satisfactory progress in the tubercular lesions than was obtained with the smaller diets; on the other hand, general health suffered considerably, as evidenced by failure of appetite and marked digestive and intestinal derangements.

Metabolism.—(1) The absorption of fat in the case of patients below their normal weight was higher than normal, even when very large quantities were ingested, *e.g.*, a patient taking 231 grammes of fat daily absorbed 96·4 per cent. The great majority of patients absorbed over 90 per cent., and in no case was the absorption below 87 per cent.

(2) The absorption of nitrogen was also high in all cases, *viz.*, 90 per cent., or over, but, when very large quantities were ingested, an increase in the amount excreted in the urine invariably occurred, and only a very small percentage of the increased amount of nitrogen ingested remained in the body. It was noticeable that the absorption, both of fat and nitrogen, was high, even in the cases suffering from acute dyspepsia.

(3) The percentage of nitrogen excreted as urea decreased, and, consequently, the percentage excreted in less oxidised form increased, indicating less complete elaboration.

Table II.—Diets and Metabolism of Three Patients treated by Forced Feeding.

Proteid	232·5	271·1	251·4	} Nutritive value of diet.
Fat	183·9	231·2	208·3	
Carbohydrate	321·3	392·1	297·2	
Total calories	4126·0	5026·0	4187·0	
Fluids	2810·0	3444·0	3234·0	
N in urine	30·8	23·8	18·1	} Metabolism figures (average of 4 days' observation).
Urea	35·5	40·6	28·4	
N in faeces	2·1	4·3	2·4	
Fat	3·8	7·8	4·4	
N absorbed (per cent.) ...	94·2	89·9	93·9	
Fat (per cent.)	97·9	96·4	97·7	

(4) The ratio of the aromatic to the alkaline sulphates excreted in the urine became smaller, indicating increased intestinal putrefaction.

The preceding table shows the nutritive values of the diets taken by three patients thus treated by forced feeding, and the results of metabolic observations during a four-day period.

Research 2. On the most Economical Lines upon which to Construct Diets having the same Nutritive Value as our Standard Diet.

In view of the large expense of dieting in most sanatoria, and in order to bring the modern dietetic treatment of tuberculosis within the reach of the poorer classes, we made a series of observations, with a view to determining the most economical lines upon which an adequate diet can be constructed.

An Economical Diet.—An analysis we made of physiologically adequate diets, taken by 100 working-class families, showed us that an adequate diet for the working classes can be bought for about 10*d.* a day, and that, in such a diet, every penny spent buys some 12·7 grammes of proteid and 329 calories. The average of these 100 satisfactory diets worked out at: proteid, 119; fat, 114; carbohydrate, 417; calories, 3687; at a cost of 10*d.* (not including money spent upon beer or other alcoholic drinks).

The aim of our work was to increase this average diet some 30 per cent. in proteid without appreciably increasing the cost.

During the course of our preliminary observations on the subject, we found that the convalescent working-class consumptive, when taking a considerable amount of exercise, such as digging in the gardens, etc., requires a larger diet than our standard diet for men at physiological rest, and we aimed, in consequence, at constructing a diet with a nutritive value of

Proteid.	Calories.
150	and 3600 approximately.

A trial of several dietaries of the above nutritive value, and constructed on the lines of ordinary dietaries, showed us that the expenditure on meat accounted for some 40 per cent. of their total cost, and that, to construct a really cheap diet, the amount of animal proteid, especially meat, must be kept down as much as possible, and considerable use made of the cheaper forms of vegetable proteid, such as peas, beans, lentils, etc. We estimated that the replacing of meat by vegetable proteid would prove an economy of 30 per cent.

In view of the widely accepted principle that animal proteid, especially meat, has some specific value in the treatment of tuberculosis, and may even be regarded as an essential in the diets for the tubercular, we decided first to

Table III.

Case.	No. of days under observation.	Nutritive value of diet.				Percent- age of animal proteid.	Percent- age of vege- table proteid.	Cost, in pence.	Weight of food taken daily, in grms.	Weekly gain in weight, in kilos.	Total gain in weight, in kilos.
		Proteid.	Fat.	Carbo- hydrate.	Calories.						
Cases of Early Disease with Normal Digestions.											
1	71	175·2	146·8	550·5	4340	44·0	56·0	11·25	4331	1·5	13·5
2	55	156·1	149·6	501·4	4085	46·1	53·9	10·81	4176	1·5	8·3
3	63	164·9	125·0	456·5	3710	48·3	51·7	10·86	3527	0·9	9·0
Cases of Advanced Disease with Impaired Digestions.											
4	47	118·7	99·4	289·0	2596	49·2	50·8	7·39	3047	Stationary	Nil
5	72	125·8	110·8	366·5	3049	43·9	56·1	8·11	3160	0·3	2·25
6	21	120·9	96·0	335·0	2761	48·0	52·0	6·26	3111	1·75	2·2
Average	55	143·6	121·3	416·5	3473	46·6	53·4	9·11	3558	0·99	5·7

Table IV.—Meat-free Diet taken by Case 2 for 55 days.

	Amount.		Nutritive value.			Cost, in pence.
	Grammes.	Ounces.	Proteid.	Fat.	Carbohydrates.	
Whole milk	2000	70	66·0	80·0	100·0	5·28
Meat	Nil	—	—	—	—	—
Butter	71	2½	—	56·8	—	1·86
Cheese	—	—	—	—	—	—
Eggs	1	1	6·0	4·0	—	0·66
Bacon	Nil	—	—	—	—	—
Total animal food ...	—	—	72·0	140·8	100·0	7·80
Bread	268	9	23·8	2·6	132·5	0·72
Potatoes	—	—	—	—	—	—
Oatmeal	50	2	8·0	3·6	33·7	0·22
Peas, beans, etc.	200	7	48·6	2·6	120·6	0·87
Sugar	40	1½	—	—	40·0	0·22
Rice, etc.	28	1	2·2	—	22·4	0·12
Jam, etc.	59	2	0·5	—	47·2	0·46
Green vegetables	q.s.	—	1·0	—	5·0	0·10
Sundries	—	—	—	—	—	0·30
Total vegetable food	—	—	84·1	8·8	401·4	3·01
Total food	—	—	156·1	149·6	501·4	10·81

Calories bought per penny, 378. Grammes of proteid bought per penny, 14·8.
Total calorie value, 4085.

satisfy ourselves as to the truth of the principle. For this purpose, we carefully observed six typical cases of pulmonary tuberculosis treated on an entirely meat-free diet. A summary of the results of these observations is shown in the following table, and a sample diet taken by one of these patients for a period of 55 days is also given.

Results of Observations as to the Value of a Meat-free Diet for the Treatment of Tuberculosis.

Our conclusions are as follows:—

(1) Vegetable proteid, as the main source of the daily intake of proteid in a diet for the tubercular, is thoroughly satisfactory, so long as a sufficient amount of it is taken.

(2) The clinical results obtained, when treating consumptives with good digestions upon meat-free diets of an adequate nutritive value, are quite as good as the results that are obtained when ordinary meat diets of a similar nutritive value are used.

(3) Owing to the bulky nature of a meat-free diet, its use is restricted to patients with normal appetites and digestions; it is unsuitable for the treatment of those with marked impairment of the alimentary tract.

(4) The use of vegetable proteid in the place of all the meat usually prescribed in an ordinary meat diet effects an economy of some 33 per cent.

On the Construction of a Cheap Diet containing an Ordinary Amount of Animal Proteid, such as Meat, etc., to Ensure Palatability and Variety, and a Certain Amount of Vegetable Proteid for the Purpose of Economy.

Our practical experience with meat-free diets showed us that, in spite of their great economy, they are not quite satisfactory, inasmuch as they require very careful cooking to make them appetising, and that even when well cooked they are not readily taken by the ordinary person accustomed to a meat dietary. To be really efficient, a diet must be to the liking of those to whom it is prescribed.

We then constructed several dietaries in which the 150 grammes of proteid which we consider to be desirable in the treatment of tuberculosis is given, partly in the form of meat and partly in the form of vegetables. The following table shows one of these diets which was taken by three tubercular patients for an average period of 26 days:—

Table V.—Diet taken by Three Men during an average period of 26 days.

	Amount.		Price retail.	Nutritive value.			Cost, in pence.
	Ounces.	Grammes.		Proteid.	Fat.	Carbo-hydrate.	
Milk (separated)	42	1200	1 <i>d.</i> per pt.	40	3	60	2·11
Meat*	7	200	7 <i>d.</i> per lb.	36	24	—	3·16
Suet	$\frac{1}{2}$	16	6 <i>d.</i> „	—	13	—	0·18
Margarine	2	54	8 <i>d.</i> „	—	43	—	1·00
Cheese (American) ...	$\frac{1}{2}$	10	7 <i>d.</i> „	3	4	—	0·15
Egg	—	—	—	—	—	—	—
Bacon	2	56	6 <i>d.</i> per lb.	4	19	—	0·75
Total animal food ...	—	—	—	83	106	60	7·35
Bread	10	282	2½ <i>d.</i> per 2 lbs.	26	3	141	0·78
Potatoes	7½	210	8 <i>d.</i> per stone	2	—	30	0·26
Peas, beans, etc.....	3½	97	2 <i>d.</i> per lb.	21	1	57	0·40
Oatmeal	2	56	2 <i>d.</i> „	8	4	37	0·25
Sugar	1½	40	2½ <i>d.</i> „	—	—	40	0·22
Jam	2	56	3½ <i>d.</i> „	—	—	33	0·44
Rice, etc.....	$\frac{1}{2}$	16	2½ <i>d.</i> „	1	—	13	0·08
Flour	2	56	1 <i>s.</i> 6 <i>d.</i> per stone	7	1	39	0·16
Green vegetables	6	170	—	1	—	8	0·25
Sundries	—	—	—	4	—	10	0·50
Total vegetable food	—	—	—	70	9	408	3·34
Total food	—	—	—	153	115	468	10·69

Total calorie value, 3616. Ratio of cost of animal to vegetable food, 68·7 : 31·3.

Grammes of proteid per penny, 14·3. Calories per penny, 337.

* Uncooked and including bone, etc., and comprising beef, mutton, pork, tinned beef, mutton, etc.

The above diet could be bought retail in London from 6*s.* to 6*s.* 6*d.* per head per week for an average sized family, according to the quality of food purchased.

The results obtained in the three cases observed on this diet were most satisfactory.

After very considerable further experience in the treatment of tuberculosis with cheap dietaries constructed on the lines which we have described, we have adopted the following dietary as being, in every way, the most efficient and satisfactory :—

Table VI.—Diet taken by 15 Patients at Coppin's Green Sanatorium during the week of observation, per man per diem.

—	Ounces.	Grammes.	Proteid.	Fat.	Carbo- hydrate.	Price per lb. or gallon.	Cost, in pence.
Milk	24·4	690	23·0	28·0	34	1s.	1·87
Meat	8·65	245	44·0	28·0	—	6½d.	3·00
Liver, etc., fish	2·0	56	10·0	7·0	—	5d.	0·63
Cheese	0·5	14	5·3	1·4	—	6d.	0·19
Dripping	0·46	13	—	11·2	—	—	—
Butter	1·05	29	—	23·0	—	1s.	0·68
Egg (1 per week)	1/7	—	1·0	0·7	—	—	0·14
Bacon	2·0	56	8·0	17·0	—	7d.	0·87
Total animal food ...	—	—	91·3	116·3	34	—	7·38
Bread	8·7	247	22·0	2·0	123	1¼d.	0·69
Potatoes	8·0	228	3·0	—	30	6d. per 14 lbs.	0·23
Pulse	3·0	85	20·0	—	53	2d.	0·38
Oatmeal	2·0	56	9·0	4·0	38	1¼d.	0·19
Sugar	5·3	150	—	—	150	2d.	0·66
Jam	1·0	28	—	—	21	3d.	0·19
Cereals	0·36	10	—	—	7	2½d.	0·05
Flour	2·0	56	6·0	—	39	1s. 6d. per stone	0·15
Sundries	q.s.	—	2·0	3·0	16	—	0·60
Total vegetable food	—	—	62·0	9·0	477	—	3·14
Total food	—	—	153·3	125·3	511	—	10·52*

Grammes of proteid bought per penny, 13·2. Calories per penny, 336. Total calorie value, 3889.

* True cost, allowing 10 per cent. for waste in cooking as explained = 11·57d.

This dietary has a thoroughly adequate nutritive value for the treatment of tuberculosis. With a daily value of proteid, 154 grammes and 3889 calories, it is especially suitable for consumptives who are convalescent and doing a certain amount of muscular work.

It is very palatable, easily digested, and allows of a considerable variety being made in the menu day by day.

It is very cheap, considering the amount of nourishment which it contains, costing only 11½d. per day.

It is very economically constructed, every penny spent upon it buying 32 grammes of proteid and 336 calories.